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Use of Synthesized Speech for Communication in Non-Vocal Developmentally Delayed Children

K.B. Hranchuk, J. Ehrenworth, and J.R. Charbonneau

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ABSTRACT

A computer programme has been developed, incorporating synthesized speech, for use in the education of developmentally delayed children. This paper presents a brief description of the programme's features followed by a complete protocol for the use of the system in a school setting.

RÉSUMÉ

Un programme machine, incorporant la parole synthétisée, a été mis au point pour faciliter l'éducation d'enfants ayant des troubles de développement. La présente communication décrit brièvement les caractéristiques du programme et présente un protocole complet pour l'utilisation du système dans une école.

USE OF SYNTHESIZED SPEECH FOR COMMUNICATION IN NON-VOCAL DEVELOPMENTALLY DELAYED CHILDREN

K.B. Hranchuk, J. Ehrenworth,* and J.R. Charbonneau

INTRODUCTION

As an adjunct to the experimental protocol to assess the yes/no communicator with severely impaired developmentally delayed children, a second study has been developed utilizing a computer system designed for communication purposes. The system, developed by the National Research Council of Canada (NRC), is known as the Elementary MOD Keyboard (EMK). Basically, the system utilizes a Commodore VIC-20, a display screen, and a program which can be operated by single or multiple switches. The system has two versions for allowing a child to communicate. This first version involves a scanning process which requires the child to identify correct words or objects on a screen by manipulating a cursor via a single or multiple switches. This procedure requires skills beyond the capacity of the children presently being serviced by the Carleton Separate School Board (CSSB). However, evaluation of the EMK version I component may be more viable in the future.

Of more importance to the present proposal is the capacity of version II of the EMK to develop communication skills in developmentally delayed children. Version II of the EMK replaces the scanning requirements of version I with an expanded keyboard which allows for direction selection of elements appearing on the screen. In addition, the EMK produces synthesized sound in the form of speech. For example, a glass and a spoon may be presented on the screen and the child will be required to depress one of two switches (one for spoon and one for glass) when asked a question. If asked "do you want to eat?" and the child depresses the switch associated with spoon, the EMK will respond with the word, eat. In this manner, developmentally delayed children will be able to functionally communicate some basic requirements for everyday living. This process requires the children to perform discriminations of the visual presentation of objects, as well as the ability to activate the correct switches associated with the objects. This proposed and associated procedure which follows is an initial attempt to train such discrimination skills in developmentally delayed children.

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*Bayshore Catholic School, Ottawa, Ontario, Canada.

Consequent to an extensive literature review (see yes/no protocol) and consultation with program staff, it was decided to attempt to train four basic concepts (eat, drink, music, and play) to three developmentally delayed non-vocal children attending Bayshore Catholic School operated by the Carleton Separate School Board. Version II of the EMK will be employed with some modifications. Due to the developmental level of the children chosen for training, it was decided that two-dimensional objects presented on a screen would be too difficult to discriminate during initial training. Therefore, the screen will not be utilized for training and will be replaced by the presentation of actual three-dimensional objects. Switches with associated pictures of the four objects will be used and activation of any individual switch will result in the correct word being generated by synthesized sound below.

METHODS

Subjects

Three children have been selected by J. Ehrenworth, speech pathologist at John Butler School. The subjects do not possess any formalized method of communication and are appropriate for the EMK research project. Before initiation of the research, appropriate consent will be obtained from the subjects parent(s) and/or guardian(s).

Setting

The following research program will be conducted at Bayshore Catholic School, a day program for multiply handicapped developmentally delayed children. The program is operated by the Carleton Separate School Board in Ottawa, Ontario. The program can accommodate 20 children and has a staff-student ratio of 5:1 with appropriate support staff, teacher aids, and consultants in speech therapy, occupational therapy, physiotherapy, and behaviour management. The teachers are all well trained in dealing with this population of children and have experience in individual and group programs. All training sessions will be carried out in a 3 m × 3 m room devoit of external distractions.

Trainers

Consequent to consultation with the program supervisor two trainers for the research project will be selected. Wherever possible the trainers will be matched for experience, training, age, and overall ability as teachers. All sessions will be conducted by these teachers, with each being responsible for training all three children on a random basis.

Apparatus

The EMK has been described in the Introduction. The three-dimensional objects used for training and testing include a glass containing juice, a crayon, a radio, and a spoon containing pudding.

Pretreatment Training

Prior to the experimental phases each child will be trained to push a single switch. This phase will ensure that each child will be able to activate the switch in a consistent manner consequent to a verbal prompt and to be adapted to the synthesized sound. The procedure will involve a combination of verbal prompts, graduated physical guidance, responding to either left, right, or centre, and random exposure to the synthesized sound. All sessions will be conducted in the training room at approximately the same time every morning and afternoon until criterion performance is obtained. Sessions will involve 15 min of training performed in the following manner. Prior to beginning training, the trainer will spend 2-3 min socializing with the child via social and physical interactions. Training trials will then begin and will be carried out using the following procedure. Consequent to obtaining eye contact the trainer will instruct the child using a verbal prompt by saying "**child's name**, push the button." If the child responds within a 30 s interval by depressing the switch and activating the synthesized sound, the trainer will label the response ("**child's name**, good, you pushed the button) and the next trial will begin. No response within the specified time period will result in the trainer repeating the instruction and using physical guidance to assist the child in pushing the switch. The amount of physical guidance required to assist the child in responding will be gradually reduced contingent upon the child's performance over trials. Social reinforcement identical to that used for verbally prompted trials will be used for physically prompted trials. The switch will be placed either 3 in. (7.6 cm) to the left or right of the child's midline and at midline over trials. Placement will be determined in a random fashion with any one positional response never required more than three times in a row and with all positions equally distributed over trials.

Baseline

Baseline sessions will involve requiring the children to indicate whether they can press one of two switches to correctly identify one of two three-dimensional objects. The switches will have two-dimensional representations of a functional response associated with each three-dimensional object. For example, one switch will have a two-dimensional picture of a child eating and the other switch will have a two-dimensional picture of a

child drinking. The three-dimensional objects used to represent these functional behaviours (i.e., eating and drinking) will be a spoon and a glass.

The best way to explain a baseline trial is by way of example. Each baseline trial will begin as follows, a child may be presented with a glass and the trainer would say "**child's name**, want to drink?", with the correct response being the child pushing the switch with the picture of the child drinking. Depression of the switch will activate the synthesized speech, "drink". Pushing the other switch may result in the synthesized sound "eat", which would be an error. Throughout baseline trials the child will be required to mmake two choice discriminations for a total of 16 trials per session. The two switches will be placed 3 in. (7.6 cm) to the left and right of the child's midline and within easy pushing distance. The EMK unit will be placed approximately 7 in. (17.8 cm) directly in front of the child. The sessions will be conducted once per day at approximately the same time in the afternoon. The teacher will record, correct, incorrect or no response (30 s time limit) data on a recording sheet. No physical prompts, corrective feedback, or social reinforcement will be used during baseline sessions. On occasion, the children will receive a small glass of juice after a session. Within sessions, the trainer will periodically praise the children for consistent responding but not contingently upon correct or incorrect responses.

EMK Training

Consequent to the baseline sessions each child will be involved in two-choice discrimination training with the EMK apparatus. The experimental paradigm used will be a multiple baseline across subjects design (1) using independent trainers (teachers). The training sessions will last 15 min and will be conducted at approximately the same time every morning and afternoon in a training area devoid of distractions. The actual training will include verbal commands, social, and edible reinforcement for correct responses, and an error correction procedure. The same method of randomly presenting the objects and questions as that used during baseline will be used during traning. All training trials will be conducted in the following manner.

The teacher will present the two switches with their associated picture and label each correctly ("**child's name**, this is a spoon and this is a cup"). Then the teacher will place one of the two three-dimensional objects above the correct switch (either spoon or glass) and ask the child for a response. The question when the spoon is presented will be "do you want to eat?", and when the glass is presented, "do you want to drink". If the child depresses the correct switch which leads to the synthesized sound

(either eat or drink) social and edible reinforcement will follow. An incorrect response will result in the utilization of an error correction procedure. Consequent to a child depressing the wrong switch, the teacher will remove the three-dimensional object, ignore the child for 5 s and then replace the object above the correct switch. The child is then asked by the teacher to "touch the object" (either spoon or glass). Immediately after asking the child to depress the correct switch, the teacher physically prompts the correct response. After the correction procedure is completed the next trial in the sequence of training commences.

Once individual subjects have achieved nine correct responses within a ten-trial sequence over two consecutive sessions, training is completed for that stage. At that point a second stage of training will begin. This stage will be identical to the initial stage in all respects but one. During this stage the three-dimensional object will be presented to the child at midline rather than above the correct switch. The same criterion for learning (9 to 10 correct responses) will be used to terminate this phase of training.

Upon completion of the above two-choice discrimination training phase, three-choice training will be implemented. All aspects of training will remain the same except a third switch and two-dimensional picture associated with a third three-dimensional object will be utilized. Completion of that phase will result in the utilization of a fourth switch and object phase of training. Reaching criterion with the four-choice discrimination task will result in termination of the experiment.

Response Recording and Reliability

Correct and incorrect responses or no responses within the defined time limits will be recorded during baseline and training. The trainers will record the responses on a data sheet designed for the purpose. Every third session will be videotaped during baseline and training sessions. All taped sessions will be analyzed for interrater reliability. Raters will be trained in the recording procedures and will be unfamiliar with the purpose of the experiment. Reliability will be calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100.

REFERENCES

1. D.M. Baer, M.M. Wolf, and T.R. Risley. Some current dimensions of applied behavior analysis. J. Appl. Behav. Anal. I: 91-97; 1968.